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# Michigan Tributary Loadings to the Upper Great Lakes

Michigan Dept of Natural Resources, Lansing

Prepared for

Environmental Protection Agency, Chicago, Ill Region V

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Environmental Monitoring

# Michigan Tributary Loadings To The Upper Great Lakes

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16. ABSTRACT

The State of Michigan, through funding by the EPA, participated in the International Joint Commission's Upper Lakes Reference Group (IJC-ULRG Work Group C) study of Lake Huron and Lake Superior tributaries. During a two year period, thirty-three of the major tributaries to Lakes Superior and Huron were sampled. This sampling program was designed to provide tributary water quality and constituent loading data to the ULRG as part of their study of these two lakes. Michigan's participation in the ULRG tributary sampling program consisted of planning, data collecting and analysis, and data reporting. The work was performed in accordance with the guidelines set forth by Work Group C (WG-C) of the ULRG. The purpose of this report is to describe Michigan's activities in this project and to summarize the resultant data and constituent loadings. For each monthly + 3 high runoff sampling visits, a number of water quality parameters were analyzed and stream flow determinations were made. Some parameters required more frequent sampling than others. A listing of the parameters sampled and their related frequency is given in Table A-2, Appendix A and STORET.

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Environmental Monitoring
July 23, 1976

# MICHIGAN TRIBUTARY

# LOADINGS TO THE UPPER GREAT LAKES

By

State of Michigan
Department of Natural Resources
Stevens T. Mason Building
Lansing, Michigan

Contract Number 68-01-1899
Project C2, ULRG-IJC
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ENVIRONMENTAL MONITORING

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## INTRODUCTION

The State of Michigan, through funding by the EPA, participated in the International Joint Commission's Upper Lakes Reference Group (IJC-ULRG) study of Lake Huron and Lake Superior tributaries. This program began in July 1973 and ended in June 1975. During this two year period, thirty-three of the major tributaries to Lakes Superior and Huron were sampled. This sampling program was designed to provide tributary water quality and constituent loading data to the ULRG as part of their study of these two lakes.

Michigan's participation in the ULRC tributary sampling program consisted of planning, data collecting and analysis, and data reporting. The work was performed in accordance with the guidelines set forth by Work Group C (WG-C) of the ULRG.

The purpose of this report is to describe Michigan's activities in this project and to summarize the resultant data and constituent loadings. This report is the final project report to EPA, and the last step in fulfilling the reporting requirements of EPA Contract No. 68-01-1899.

### Monitoring Network

The sampling network Michigan established, following the Work Group C guidelines, consisted of sixteen Lake Superior tributaries and seventeen Lake Huron tributaries.

The initial program, as outlined for WG-C consisted of thirty-three stations, one on each of the significant tributaries to Lakes Superior and Huron. However, initial field visits and later reconnaissance indicated that some of the initial stream sites were adversely affected by lake water. To avoid the dilution effects of the lakes, new stations were selected upstream. This occasionally resulted in placing a station above the confluence of a major tributary to that stream. Consequently, two stations were needed to obtain the necessary data to compute loadings for the tributary. Table A-1 in Appendix A lists the Lakes Superior and Huron tributaries sampled in this project. This table includes the original station locations associated with each tributary, and any appropriate additions are listed in chronological order.

Each of these tributaries was sampled monthly, with three extra samplings occurring during the high runoff periods of the spring months according to the following schedule:

1.) Lake Superior tributaries: Bi-monthly sampling during April, May and June.

2.) Lake Huron tributaries: Bi-monthly sampling during March, April and May.

For each sampling visit a number of water quality parameters were analyzed and stream flow determinations were made. Some parameters required more frequent sampling than others. A listing of the parameters sampled and their related frequency is given in Table A-2, Appendix A.

## Data Collection and Analysis

Michigan sub-contracted the Upper Peninsula tributary sampling to Environmental Research Group, Inc. (ERG, Inc.) of Ann Arbor, Michigan. ERG collected water samples and determined stream flows where U.S. Geological Survey (USGS) data was not available, at all of the Upper Peninsula tributary monitoring stations. In addition, ERG performed all the necessary laboratory analytical work required, including inter-laboratory comparisons with Michigan. The Lower Peninsula tributaries were sampled by Michigan and these samples were analyzed by our laboratories. In addition, stream flow data was provided by Michigan at all streams not included in the U.S. Geological Survey program.

Sample collection by Michigan and ERG was essentially the same, each using similar sampling apparatus. All samples were subsequently transported to the appropriate laboratories within 30 hours after sampling, where all analytical work was conducted. The exceptions to the above are for the following analytical test performed by the indicated agency in the field:

1.) Michigan - Field determination for temperature only.

2.) ERG - Field determinations for temperature, dissolved oxygen, 5-day biochemical oxygen demand, conductivity, pH, total coliforms and fecal coliforms.

Both the Michigan Laboratory and the ERG Laboratory used similar analytical techniques in their analysis of water samples. Numerous samples were split between laboratories to assure similar results. Individual analyses were performed by approved EPA methods. Table A-3 in Appendix A lists the methodology used for each of the parameters analyzed. Table A-4 lists the field preservation techniques used by the field crews for all parameters not analyzed in the field.

Stream flow measurements were determined at each sampling site with each visit. Stream flow was determined where possible using appropriate USGS guage sites and extrapolating stream flow using a drainage area ratio for the sampling station. When no USGS guage was available field determinations of stream flow was made at the time of sampling. The field methods employed, were either on-site stream guaging at the time of sampling or developing a stage-discharge relationship near the sampling site. The latter method enabled the field crew to determine water depth from a reference mark or staff guage. This measurement was used to calculate stream flow from the stage-discharge curves. Table A-5 in Appendix A summarizes the method of stream flow determination used for each of the tributary streams.

## Data Reporting

A report of this two year study was submitted to the IJC-ULRG. This report, entitled "Land Source Inputs to Upper Great Lakes from the U.S."[1] consisted of a data summary and materials loadings for all the ULRG tributaries of Michigan, Minnesota and Wisconsin. In addition, loadings were calculated for the ULRG municipal and industrial direct point source inputs from these three agencies (for this report to EPA, only Michigan tributary loadings are included).

The data gathered by the three jurisdictions was assembled by Michigan and loadings were calculated using a computer program developed by Michigan. The entire project report is included in Appendix B. The following table, "Summary of Tributary Inputs to Lakes Superior and Huron from Michigan" was constructed from the project report.

TABLE 1

SUMMARY OF TRIBUTARY INPUTS TO LAKES SUPERIOR AND HURON FROM MICHIGAN

Compiled from WG-C Project Report to ULRG[1]

ALL LOADINGS ARE EXPRESSED IN METRIC TONS/YEAR

| PARAMETER | LAKE SUPERIOR | LAKE HURON |
|---|---|---|
| Alkalinity | 249,000 | 1,829,000 |
| Arsenic, dissolved | 16 | 9 |
| Barium, dissolved | 640 | 765 |
| Biochemical oxygen demand | 7,400 | 42,000 |
| Cadmium, dissolved | 8 | 14 |
| Calcium | 99,300 | 625,000 |
| Total organic carbon | 269,000 | 287,000 |
| Chemical oxygen demand | 250,000 | 350,000 |
| Chloride | 36,900 | 406,000 |
| Chromium, dissolved | 32 | 3 |
| Copper, dissolved | 38 | 46 |
| Cyanide | 14 | Not detected |
| Fluoride, dissolved | 1,100 | 2,500 |
| Iron | 5,400 | 20,400 |
| Lead, dissolved | 250 | 100 |
| Magnesium | 21,200 | 180,000 |
| Manganese, dissolved | 88 | 260 |
| Mercury | 5 | 1 |
| Nickel, dissolved | 28 | 62 |
| Nitrogen, total | 4,000 | 24,800 |
| Nitrogen, Nitrate + Nitrite | 2,700 | 13,400 |
| Nitrogen, Organic | 450 | 9,500 |
| Nitrogen, Ammonia | 832 | 2,000 |
| Oil & Grease | 3,900 | 26,400 |
| Pesticides, total | Less than 1 | Less than 1 |
| Phenols | 20 | 69 |
| Phosphorus | 210 | 2,100 |
| Phosphorus, Soluble | 100 | 870 |
| Phthalates, Diethylhexyl | Less than 1 | 64 |
| Polychlorinated biphenyl | Not detected | Less than 1 |
| Potassium | 13,300 | 23,400 |
| Selenium, dissolved | 10 | 3 |
| Silica, dissolved | 16,900 | 85,300 |
| Silver, dissolved | 18 | 29 |
| Sodium | 26,500 | 173,000 |
| Total solids | 774,000 | 4,250,000 |
| Total dissolved solids | 456,000 | 3,580,000 |
| Total suspended solids | 195,000 | 436,000 |
| Sulfate, dissolved | 51,100 | 402,000 |
| Zinc, dissolved | 160 | 140 |

APPENDIX A

TABLE A-1

TRIBUTARY SAMPLING STATIONS USED FOR THE ULRG STUDY

LAKE SUPERIOR BASIN

| Tributary Name[1] | Station No. | County | Period of Record[2] |
|---|---|---|---|
| Betsy River | 170010 | Chippewa | 7/73 - 6/75 |
| Black River | 270018 | Gogebic | 7/73 - 6/75 |
| Carp River | 520033 | Marquette | 7/73 - 6/75 |
| Chocolay River | 520084 | Marquette | 7/73 - 6/75 |
| Dead River | 520083 | Marquette | 7/73 - 6/75 |
| Falls River | 070007 | Baraga | 7/73 - 11/73 & 11/74-6/75 |
| | 070027 | Baraga | 12/73 - 10/74 |
| Iron River | 660005 | Ontonagon | 7/73 - 9/73 |
| | 660047 | Ontonagon | 10/73 - 6/75 |
| Mineral River | 660021 | Ontonagon | 7/73 - 6/75 |
| Montreal River | 270004 | Gogebic | 7/73 - 6/75 |
| Ontonagon River | 660004 | Ontonagon | 7/73 - 9/73 |
| | 660038 | Ontonagon | 10/73 - 6/75 |
| Presque Isle River | 270005 | Gogebic | 7/73 - 8/73 |
| | 270019 | Gogebic | 9/73 - 6/75 |
| Silver River | 070026 | Baraga | 7/73 - 11/73 |
| | 070029 | Baraga | 12/73 - 6/75 |
| Sturgeon River | 310006 | Houghton | 7/73 - 6/75 |
| Tahquamenon River | 170007 | Chippewa | 7/73 - 6/75 |
| Two Hearted River | 480009 | Luce | 7/73 - 6/75 |
| Waiska River | 170043[3] | Chippewa | 7/73 - 11/73 |
| E. Branch | 170046 | Chippewa | 12/73 - 6/75 |
| W. Branch | 170047 | Chippewa | 12/73 - 6/75 |

LAKE HURON BASIN

| Tributary Name[1] | Station No. | County | Period of Record[2] |
|---|---|---|---|
| Au Gres River | 060025 | Arenac | 7/73 - 10/73 |
| | 060023 | Arenac | 11/73 - 6/75 |
| Au Sable River | 350022 | Iosco | 7/73 - 9/73 |
| | 350058 | Iosco | 10/73 |
| | 350061 | Iosco | 11/73 - 6/75 |
| (Van Etten Creek) | 350062 | Iosco | 11/73 - 6/75 |
| Cheboygan River | 160023 | Cheboygan | 7/73 - 10/73 |
| | 160053 | Cheboygan | 11/73 - 6/75 |
| Kawkawlin River | 090007 | Bay | 7/73 - 6/75 |
| Ocqueoc River | 710033 | Presque Isle | 7/73 - 6/75 |
| Pigeon River | 320093 | Huron | 7/73 - 6/75 |
| Pinconning River | 090065 | Bay | 7/73 - 6/75 |

(LAKE HURON BASIN CONTINUED)

| Tributary Name[1] | Station No. | County | Period of Record[2] |
|---|---|---|---|
| Pine River | 490006 | Mackinac | 7/73 - 6/75 |
| Pine River | 060006 | Arenac | 7/73 - 6/75 |
| Pinnebog River | 320027 | Huron | 7/73 - 2/74 |
| | 320100 | Huron | 3/74 - 6/75 |
| Rifle River | 060007 | Arenac | 7/73 - 6/75 |
| Saginaw River | 090008[3] | Bay | 7/73 - 10/73 |
| | 090162 | Bay | 11/73 - 6/75 |
| Sebewaing River | 320024 | Huron | 7/73 - 6/75 |
| Tawas River | 350021 | Iosco | 7/73 - 9/73 |
| | 350059 | Iosco | 10/73 - 6/75 |
| Thunder Bay River | 040014[3] | Alpena | 7/73 - 10/73 |
| | 040067 | Alpena | 11/73 - 6/75 |
| Whitney Drain | 060031 | Arenac | 7/73 - 6/75 |
| Willow River | 320026 | Huron | 7/73 - 6/75 |

[1] The tributaries listed are the principal tributaries selected at the beginning of the program. As noted, more than one station may be associated with each tributary.

[2] The period of record lists the beginning and ending months of sampling. For instance, 7/73 - 10/73 means that the first sample was collected in July 1973 and the last sample was collected in October 1973.

[3] These stations were initially sampled in the program. However, the effects of lake water intrusion greatly biased the sample rendering the data useless. Therefore, these stations were not included in the loadings computation.

TABLE A-2

WATER QUALITY PARAMETERS AND THEIR FREQUENCY OF SAMPLING*

A. Items for routine sampling of tributaries at least monthly and bi-monthly during spring runoff:

| Microbiological | Physical | Chemical |
|---|---|---|
| total coliform | flow | dissolved oxygen |
| fecal coliform | temperature | phenol |
| | pH | total iron |
| | conductivity | total phosphorus |
| | turbidity | silica |
| | suspended solids | ammonia nitrogen |
| | | total nitrogen |
| | | chloride |
| | | alkalinity |
| | | manganese |
| | | biochemical oxygen demand |

Others

As needed or described in agency programs

nitrate nitrogen
soluble phosphorus
organic nitrogen
total solids
total dissolved solids

B. Items for sampling at least three times per year, for background information:

| Radiological | Organics | Others | Metals |
|---|---|---|---|
| gross beta | pesticides | cyanide | arsenic |
| tritium | oil | fluoride | barium |
| strontium | chlorinated hydrocarbons | sulfate | cadmium |
| radium | total organic carbon | chemical oxygen demand | chromium |
| | polychlorinated biphenyls | | copper |
| | phthalates | | lead |
| | | | mercury |
| | | | nickel |
| | | | selenium |
| | | | zinc |
| | | | calcium |
| | | | magnesium |
| | | | sodium |
| | | | potassium |
| | | | silver |

*This material is the preliminary study plan for Working Group C, ULRG

TABLE A-3

General Chemical and Physical Analytical
Methods for Water Samples

March 1976

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

WATER RESOURCES COMMISSION LABORATORY

General Chemical and Physical Analytical Methods for Water Samples

March 1976

| Parameter | Storet Number | Min. Volume ml (1) | Optimum Range | | Method of Analysis | References | | |
|---|---|---|---|---|---|---|---|---|
| | | | Surface Water | Waste Water | | Standard Methods 1971 (2) | EPA Methods 1974 (3) | ASTM Part 31 1974 (4 |
| Acidity, Total, Hot | 70508 | 100 | ------- | 2-200 mg $CaCO_3$/l | Phenolphthalein Endpoint | ------- | p. 1 | D1067-70E p. 124 |
| Alkalinity, Bicarbonate | 00425 | 150 | 1-250 mg $CaCO_3$/l | 1-250 mg $CaCO_3$/l | Difference of Total and Carbonate Alkalinity | 102 p. 55 | ------- | ------- |
| Alkalinity, Carbonate | 00430 | 100 | 1-250 mg $CaCO_3$/l | 1-250 mg $CaCO_3$/l | Phenolphthalein Endpoint | 102 p. 55 | ------- | ------- |
| Alkalinity, Total | 00410 | 50 | 1-250 mg $CaCO_3$/l | 1-250 mg $CaCO_3$/l | Automated Methyl Orange | ------- | p. 5 | ------- |
| Aluminum, Total | 01105 | 100 | ------- | 200-10,000 ug Al/l | Atomic Absorption | 129 p. 210 | p. 92 | ------- |
| Aluminum, Dissolved | 01106 | | | | (5) | | | |
| Antimony, Total | 01097 | 100 | ------- | 500-10,000 ug Sb/l | Atomic Absorption | ------- | p. 94 | ------- |
| Antimony, Dissolved | 01095 | | | | (5) | | | |
| Arsenic, Total | 01002 | 500 | 1-10 ug As/l | 10-100 ug As/l | Atomic Absorption, Gaseous Hydride | ------- | p. 95 | ------- |
| Arsenic, Dissolved | 01000 | | | | (5) | | | |

| Parameter | Storet Number | Min. Volume ml (1) | Surface Water | Waste Water | Method of Analysis | Standard Methods 1971 (2) | EPA Methods 1974 (3) | ASTM Part 31 1974 (4 |
|---|---|---|---|---|---|---|---|---|
| Barium, Total | 01007 | 1000 | 10-500 ug Ba/l | 200-10000 ug Ba/l | Atomic Absorption | 129 p. 210 | p. 97 | ------- |
| Barium, Dissolved | 01005 | | | | (5) | | | |
| Beryllium, Total | 01012 | 100 | ------- | 50-2000 ug Be/l | Atomic Absorption | 129 p. 210 | p. 99 | ------- |
| Beryllium, Dissolved | 01010 | | | | (5) | | | |
| Biochemical Oxygen Demand, 5 Day | 00310 | 300 | 0.5-8 mg/l | 25-1000 mg/l | Probe Method, 20°C | 219 (6) p. 489 | p. 11 (6) | ------- |
| Biochemical Oxygen Demand, 20 Day | 00324 | 300 | 0.5-8 mg/l | 25-1000 mg/l | Probe Method, 20°C | 219 (6) p. 489 | ------- | ------- |
| Biochemical Oxygen Demand, Carb., 20 Day | 80087 | 300 | 0.5-8 mg/l | 25-1000 mg/l | Probe Method minus Nitrification, 20°C | 219 (6) p. 489 | ------- | ------- |
| Boron, Total | 01022 | 50 | 100-3000 ug B/l | 100-3000 ug B/l | Curcumin Method | 107A p. 69 | p. 13 | ------- |
| Boron, Dissolved | 01020 | | | | (5) | | | |
| Bromide | 71870 | 100 | 0.1-10. mg Br/l | 1-100 mg Br/l | Specific Ion Electrode | ------- | ------- | ------- |
| Cadmium, Total | 01027 | 100 | 0.1-2.0 ug Cd/l | 10-2000 ug Cd/l | Atomic Absorption, Flameless or Conventional Method | 129 p. 210 | p. 101 | D2576-70 p. 351 |
| Cadmium, Dissolved | 01025 | | | | (5) | | | |
| Calcium, Total | 00916 | 200 | 10-100 mg Ca/l | 20-200 mg Ca/l | EDTA Titration | 110C p. 84 | p. 19 | |
| Carbon Dioxide | 00405 | 250 | 0.1-50 mg $CO_2$/l | ------- | Nomographic Determination | 111A p. 87 | ------- | ------- |

| Parameter | Storet Number | Min. Volume ml (1) | Optimum Range: Surface Water | Optimum Range: Waste Water | Method of Analysis | References: 1971 (2) Standard Methods | References: EPA Methods 1974 (3) | References: ASTM Part 31 1974 (4 |
|---|---|---|---|---|---|---|---|---|
| Carbon, Total Organic | 00680 | 50 | 0.1-50 mg C/l | ------- | Sealed Ampul, Combustion, IR | 138A (6) p. 257 | ------- | D2579-74 p. 467(6 |
| Carbon, Total Organic | 00680 | 50 | ------- | 1-2000 mg C/l | Direct Injection, Combustion, Methane Detection | ------- | p. 236 | ------- |
| Chemical Oxygen Demand, High Level | 00340 | 50 | ------- | 2-800 mg/l | Dichromate, Test Tube | 220 (6) p. 495 | p. 20 (6) | D1252-67 p. 472(6 |
| Chemical Oxygen Demand, Low Level | 00335 | 50 | 0.3-80 mg/l | ------- | Dichromate, Test Tube | 220 (6) p. 495 | p. 21 (6) | D1252-67 p. 472(6 |
| Chloride | 00940 | 50 | 0.1-100 mg Cl/l | 1-500 mg Cl/l | Automated Ferricyanide | ------- | p. 31 | ------- |
| Chlorine, Total Residual | 50060 | 500 | 0.1-3.0 mg/l | 1-10 mg/l | Iodometric Method (7) | 114A p. 110 | ------- | ------- |
| Chlorophyll A | 32209 | 100 | 0.1-10 ug/l | ------- | Fluorometric, Corrected | 602C p. 748 (6) | ------- | ------- |
| Chromium, Total | 01034 | 1000 | 1-500 ug Cr/l | 10-5000 ug Cr/l | Atomic Absorption | 129 p. 210 | p. 105 | D2576-70 p. 351 |
| Chromium, Dissolved | 01030 | | | | (5) | | | |
| Chromium, Hexavalent | 01032 | 50 | 10-1000 ug/l | 10-1000 ug/l | Diphenylcarbazide Method | 117A p. 156 | ------- | ------- |
| Chromium, Trivalent | 01033 | 1000 | ------- | 10-1000 ug/l | Total minus Hexavalent Chromium | ------- | ------- | ------- |
| Cobalt, Total | 01037 | 100 | ------- | 100-2000 ug Co/l | Atomic Absorption | ------- | p. 107 | D2576-70 p. 351 |
| Cobalt, Dissolved | 01035 | | | | (5) | | | |
| Color | 00080 | 50 | 1-500 Pt. Co | ------- | Platinum-Cobalt Method | 118 p. 160 (6) | p. 36 (6) | ------- |

| Parameter | Storet Number | Min. Volume ml (1) | Surface Water | Waste Water | Method of Analysis | 1971 (2) Standard Methods | EPA Methods 1974 (3) | ASTM Part 31 1974(4) |
|---|---|---|---|---|---|---|---|---|
| Conductivity | | | | | See Specific Conductance | | | |
| Copper, Total | 01042 | 1000 | 1-500 ug Cu/l | 10-5000 ug Cu/l | Atomic Absorption | 129 p. 210 | p. 108 | D2576-70 p. 351 |
| Copper, Dissolved | 01040 | | | | (5) | | | |
| Cyanide, Free | 00722 | 500 | ------- | 0.01-1.00 mg CN/l | Chlorination, Pyridine-Barbituric Acid Method | ------- | p.49 | D2036-74B p. 505 |
| Cyanide, Total | 00720 | 250 | 0.01-1.00 mg CN/l | 0.01-1.00 mg CN/l | Pyridine-Barbituric Acid Method (8) | ------- | p. 40 | D2036-74A p. 503 |
| Fluoride, Total | 00951 | 50 | 0.01-2.00 mg F/l | 0.01-2.00 mg F/l | Specific Ion Electrode | 121B p. 172 | p. 65 | D1179-B p. 313 |
| Hardness, Total | 00900 | 100 | 5-500 mg $CaCO_3$/l | 5-500 mg $CaCO_3$/l | EDTA Titration | 122B p. 179 | p. 68 | D1126-67B p. 169 |
| Iodide | 71865 | 50 | ------- | 0.01-0.10 mg I/l | Photometric | 123A p. 185 | ------- | D1246-68A p. 325 |
| Iron, Total | 01045 | 1000 | 5-500 ug Fe/l | 50-5000 ug Fe/l | Atomic Absorption | 129 p. 120 | p. 110 | D2576-70 p. 351 |
| Iron, Dissolved | 01046 | | | | (5) | | | |
| Lead, Total | 01051 | 50 | 1-10 ug Pb/l | ------- | Atomic Absorption, Flameless | ------- | ------- | ------- |
| Lead, Dissolved | 01049 | | | | (5) | | | |
| Lead, Total | 01051 | 200 | ------- | 50-5000 ug Pb/l | Atomic Absorption | 129 p. 210 | p. 112 | D2576-70 p. 351 |
| Lead, Dissolved | 01049 | | | | (5) | | | |

| Parameter | Storet Number | Min. Volume ml (1) | Surface Water | Waste Water | Method of Analysis | Standard Methods 1971 (2) | EPA Methods 1974 (3) | ASTM Part 31 1974 (4) |
|---|---|---|---|---|---|---|---|---|
| Lithium, Total | 01132 | 1000 | 1-500 ug Li/l | ------- | Atomic Absorption | ------- | ------- | ------- |
| Lithium, Dissolved | 01130 | | | | (5) | | | |
| Magnesium, Total | 00927 | 50 | 0.1-25. mg Mg/l | 0.1-25. mg Mg/l | Atomic Absorption | 129 p. 210 | p. 114 | D2576-70 p. 351 |
| Manganese, Total | 01055 | 1000 | 1-200 ug Mn/l | 10-2000 ug Mn/l | Atomic Absorption | 129 p. 210 | p. 116 | D2576-70 p. 351 |
| Manganese, Dissolved | 01056 | | | | (5) | | | |
| Mercury, Total | 71900 | 500 | 0.2-10 ug Hg/l | 0.2-10 ug Hg/l | Cold Vapor Method | ------- | p. 118 | D3223-73 p. 344 |
| Methylene Blue Active Substances | 38260 | 250 | ------- | 0.01-1.00 mg/l | Methylene Blue Method | 159A p. 339 | p. 157 | D2330-68 p. 494 |
| Molybdenum, Total | 01062 | 100 | ------- | 100-10,000 ug Mo/l | Atomic Absorption | ------- | p. 139 | ------- |
| Molybdenum, Dissolved | 01060 | | | | (5) | | | |
| Nickel, Total | 01067 | 1000 | 5-500 ug Ni/l | 50-5000 ug Ni/l | Atomic Absorption | ------- | p. 141 | D2576-70 p. 351 |
| Nickel, Dissolved | 01065 | | | | (5) | | | |
| Nitrogen, Ammonia, Total | 00610 | 50 | 0.001-0.50 mg N/l | 0.01-5.0 mg N/l | Automated Phenate | ------- | p. 168 | ------- |
| Nitrogen, Kjeldahl, Total | 00625 | 50 | 0.01-2.00 mg N/l | 0.01-2.0 mg N/l | Block Digestor, Automated Salicylate | ------- | ------- | ------- |
| Nitrogen, Nitrate plus Nitrite, Total | 00630 | 50 | 0.01-2.00 mg N/l | 0.01-2.0 mg N/l | Automated Cadmium Reduction | ------- | p. 207 | ------- |

| Parameter | Storet Number | Min. Volume ml (1) | Surface Water | Waste Water | Method of Analysis | Standard Methods 1971 (2) | EPA Methods 1974 (3) | ASTM Part 31 1974 (4) |
|---|---|---|---|---|---|---|---|---|
| Nitrogen, Nitrite, Total | 00615 | 50 | 0.001-0.100 mg N/l | 0.01-0.20 mg N/l | Diazotization, Colorimetric | ------- | p. 215 | ------- |
| Nitrogen, Organic, Total | ,00605 | 100 | 0.01-2.00 Mg N/l | 0.01-2.0 mg N/l | Kjeldahl Nitrogen minus Ammonia | ------- | ------- | ------- |
| Nitrogen, Total | 00600 | 150 | 0.01-4.00 mg N/l | ------- | Sum of Nitrate plus Nitrite and Kjeldahl Nitrogen | ------- | ------- | ------- |
| Oil and Grease | 00560 | 500 | 1-30 mg/l | 1-30 mg/l | Freon Extraction - IR Method | ------- | p. 232 | ------- |
| Oxygen, Dissolved | 00300 | 300 | 0.1-20 mg/l | 0.1-20 mg/l | Modified Winkler | 218B p. 477 | p. 51 | D1589-60 p. 37 |
| pH | 00400 | 200 | 6.5-9.5 SU | 0.0-14.0 SU | Electrometric | 221 p. 500 | p. 239 | D1293-65 p. 186 |
| Phenolics, Total, Recoverable | 32730 | ~~1000~~ 500 ml | 0.5-40 ug/l | 10-3000 ug/l | Distillation, 4AAP | 222B,C,D p. 502 | p. 241 | D1783-70 p. 542 |
| Phosphate, Ortho, Total (9) | 70507 | 50 | 0.001-0.50 mg P/l | 0.01-5.0 mg P/l | Automated Single Reagent Ascorbic Acid Reduction | ------- | p. 256 (6) | ------- |
| Phosphorus, Total | 00665 | 50 | 0.001-0.50 mg P/l | 0.01-5.0 mg P/l | Block Digestor, (10) Automated Single Reagent | ------- | p. 256 (6) | ------- |
| Potassium, Total | 00937 | 50 | 0.01-4.0 mg K/l | 0.01-4.0 mg K/l | Atomic Absorption | ------- | p. 143 | ------- |
| Residue, Settleable | 00546 | 500 | 1-100 mg/l | 1-100 mg/l | Gravimetric, 1 Hour (11) Glass Fiber Filtration 105°C | 224F p. 539 | p. 268 (6) | ------- |
| Residue, Total | 00500 | 500 | 100-1000 mg/l | ------- | Sum of Filtrable and Non-filtrable Residues | ------- | ------- | ------- |
| Residue, Total | 00500 | 250 | ------- | 100-10000 mg/l | Gravimetric, 105°C | 224A p. 535 | p. 270 | ------- |
| Residue, Total Filtrable | 70300 | 250 | 300-1000 mg/l | 300-10000 mg/l | Gravimetric, Glass Fiber Filtered, 180°C | ------- | p. 266 | ------- |

| Parameter | Storet Number | Min. Volume ml (1) | Surface Water | Waste Water | Method of Analysis | Standard Methods 1971 (2) | EPA Methods 1974 (3) | ASTM Part 31 1974 (4) |
|---|---|---|---|---|---|---|---|---|
| Residue, Total Nonfiltrable | 00530 | 250 | 1-100 mg/l | 1-100 mg/l | Gravimetric, Glass Fiber Filtration, 105°C | 224C p. 537 | p. 268 | ------- |
| Residue, Total Volatile | 00505 | 500 | ------- | 4-2000 mg/l | Gravimetric, 550°C | 224B p. 536 | p. 272 | ------- |
| Residue, Volatile Filtrable | 00520 | 250 | ------- | 4-2000 mg/l | Gravimetric, Glass Fiber Filtered, 550°C | ------- | p. 272 | ------- |
| Residue, Volatile Nonfiltrable | 00535 | 250 | 1-100 mg/l | 1-100 mg/l | Gravimetric, Glass Fiber Filtration, 550°C (12) | 224D p. 538 | p. 272 | ------- |
| Selenium, Total | 01147 | 500 | 2-10 ug Se/l | 10-100 ug Se/l | Atomic Absorption Gaseous Hydride | ------- | p. 145 | ------- |
| Selenium, Dissolved | 01145 | | | | (5) | | | |
| Silica, Dissolved (13) | 00955 | 50 | 0.01-10.0 mg $SiO_2$/l | 0.1-10.0 mg $SiO_2$/l | Automated Molybdosilicate | 151B p. 302 (6) | ------- | ------- |
| Silver, Total | 01077 | 1000 | 1-200 ug Ag/l | ------- | Atomic Absorption | 129 p. 210 | p. 146 | ------- |
| Silver, Dissolved | 01075 | | | | (5) | | | |
| Sodium, Total | 00929 | 50 | 0.1-50. mg Na/l | 0.1-50. mg Na/l | Atomic Absorption | ------- | p. 147 | ------- |
| Solids | | | | | See Residues | | | |
| Solids, Dissolved | 70301 | 1000 | 50-500 mg/l | ------- | Sum of Constituents | 100C p. 38 (6) | ------- | ------- |
| Solids, Dissolved, Total | 47004 | 100 | 50-350 mg/l | ------- | 65% of Specific Conductance at 25°C | ------- | ------- | ------- |
| Specific Conductance | 00095 | 100 | 100-1500 umho/cm | 100-2500 umho/cm | Wheatstone Bridge, Corrected to 25°C | 154. p. 323 | p. 275 | D1125-6 p. 128 |

| Parameter | Storet Number | Min. Volume ml (1) | Minimum Range | | Method of Analysis | Reference | | |
|---|---|---|---|---|---|---|---|---|
| | | | Surface Water | Waste Water | | Standard Methods 1971 (2) | EPA Methods 1974 (3) | ASTM Part 31 1974 (4 |
| Sulfate, Dissolved (14) | 00946 | 100 | 0.1-100 mg $SO_4$/l | 1-100 mg $SO_4$/l | Barium Chloride Turbimetric | 156C (6) p. 334 | p. 277 (6) | D5168-6 p. 428( |
| Sulfide, Total | 00745 | 100 | ------- | 0.05-10. mg S/l | Methylene Blue Method | 228C p. 558 | ------- | ------- |
| Sulfide, Total | 00745 | 100 | ------- | 10-100 mg S/l | Titrimetric, Iodine | 228A p. 552 | p. 284 | ------- |
| Sulfite | 00740 | 250 | ------- | 1-50 mg $SO_3$/l | Titrimetric, Iodide-Iodate | 158 p. 337 | p. 285 | D1339-7 p. 438 |
| Tannin and Lignin | 32240 | 250 | ------- | 50-1000 mg/l | Tungstophosphoric and Molybdophosphoric Acid | 160 p. 346 | ------- | ------- |
| Thallium, Total | 01059 | 100 | ------- | 500-10,000 ug Tl/l | Atomic Absorption | ------- | p. 149 | ------- |
| Thallium, Dissolved | 01057 | | | | (5) | | | |
| Tin, Total | 01102 | 100 | ------- | 500-2000 ug Sn/l | Atomic Absorption | ------- | p. 150 | ------- |
| Tin, Dissolved | 01100 | | | | (5) | | | |
| Titanium, Total | 01152 | 1000 | 100-500 ug Ti/l | 2000-10,000 ug Ti/l | Atomic Absorption | ------- | p. 151 | ------- |
| Titanium, Dissolved | 01150 | | | | (5) | | | |
| Turbidity | 00076 | 50 | 0.1-100 FTU | 1-100 FTU | Hach Turbidimeter | 163A p. 350 | p. 295 | D1889-7 p. 231 |
| Vanadium, Total | 01087 | 100 | ------- | 500-10,000 ug V/l | Atomic Absorption | ------- | p. 153 | ------- |
| Vanadium, Dissolved | 01085 | | | | (5) | | | |

| Parameter | Storet Number | Min. Volume ml (1) | Working Range | | Method of Analysis | References | | |
|---|---|---|---|---|---|---|---|---|
| | | | Surface Water | Waste Water | | Standard Methods 1971 (2) | EPA Methods 1974 (3) | ASTM Part 31 1974 (4) |
| Zinc, Total | 01092 | 1000 | 1-200 ug Zn/l | 10-2000 ug Zn/l | Atomic Absorption | 210 p. 129 | p. 155 | D2576-70 p. 351 |
| Zinc, Dissolved | 01090 | | | | (5) | | | |

Notes

1. Minimum sample volumes are based on volumes needed to perform quality assurance analyses and repeat analysis if necessary. Less volume may be acceptable for some parameters. Volumes are not additive where multiple determinations may be performed on one sample aliquot, such as most metal and automated analyses.

2. Standard Methods for the Examination of Water and Wastewater, 13th ed., 1971, American Public Health Association. Method number and page listed.

3. Methods for Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agnecy, 1974. Page listed.

4. Annual Book of ASTM Standards, Part 31, Water, American Society for Testing and Materials, 1974. Method number and page listed.

5. Dissolved parameter analyzed the same as preceding total parameter except sample aliquot is membrane filtered prior to any sample treatment. Sample volume, ranges, method of analysis, and references the same as preceding except as noted.

6. Principles of referenced material used although changes in technique have been adapted.

7. DPD (N,N-diethyl-p-phenylenediamine) colorimetric method performed as a screening procedure with positive results confirmed with iodometric tiration.

8. Preliminary distillation omitted on surface water samples unless positive results or interferences are encountered.

9. Phosphates other than ortho may react. Could more properly be titled Unfiltered Reactive Phosphates.

10. If Kjeldahl or Organic Nitrogen is not also requested on sample, analysis may be performed manually with persulfate digestion followed by single reagent-ascorbic acid reduction method.

11. Settleable Residue analysis not performed on samples with a Total Nonfiltrable Residue of less than 20 mg/l.

12. Volatile Nonfiltrable Residue analysis not performed on samples with a Total Nonfiltrable Residue of less than 10 mg/l.

13. Sample not membrane filtered unless a turbidity interference in encountered.

14. Sample glass fiber filtered to remove turbidity interference but is not membrane filtered.

TABLE A-4

Sample Collection and Preservation
January 1975

| Parameter | Bottle | Preservation | Maximum Holding Period |
|---|---|---|---|
| Biochemical Oxygen Demand, 5-day | 300 ml glass | Refrigeration at 4°C | 30 hours |
| Chlorophyll a | 1 L dark | 5 drops 1% $MgCO_3$ | 30 hours |
| Chemical Oxygen Demand | 250 ml | 1 ml 1:1 $H_2SO_4$-- 4°C | 7 days |
| Cyanide | 125 ml | 2 drops 10 N NaOH (to pH 10) | 30 hours |
| Dissolved Oxygen | 250 ml glass | Determine or fix on site | Does Not Apply |
| General Chemistry | 1 L | Refrigeration at 4oC | 30 hours |
| Metals, Dissolved | 1 L | 10 ml 1:1 $HNO_3$ after filtration | 6 months |
| Metals, Total | 1 L | 10 ml 1:1 $HNO_3$ | 6 months |
| Microbiology | 125 ml | Refrigeration at 4°C | 30 hours |
| Nutrients | 125 ml | 5 drops $CHCl_3$ --- 4°C | 30 hours |
| Oil and Grease | 250 ml glass | 1 ml 1:1 $H_2SO_4$ -- 4°C | 30 hours |
| Pesticides, PCB's Phthalate | 1 gal glass | 100 ml Hexane | 1 month |
| Petroleum Products, Identification | 250 ml glass | Refrigeration at 4°C | 30 hours |
| Phenolics | 250 ml | 2 ml 10% $CuSO_4$ + $H_3PO_4$ to pH 4 --- 4°C | 30 hours |
| Phenolics (<10 ug/l) | 1 L | 8 ml 10% $CuSO_4$ + $H_3PO_4$ to pH 4 -- 4°C | 30 hours |
| Specific Organics | 1L-1Gal glass | Dependent on the parameter | 30 hours |
| Sulfide | 125 ml | 5 drops 1 M ZnAc | 7 days |
| Volatile Hydrocarbons | 300 ml glass | Water sealed -- 4°C | 30 hours |
| Total Organic Carbon | 125 ml | 1 ml 1:1 HCl --- 4°C | 7 days |

TABLE A-5

STREAM FLOW MEASURING TECHNIQUES FOR THE UIRG TRIBUTARIES

| TRIBUTARY | METHOD OF STREAM FLOW DETERMINATION |
|---|---|
| | LAKE SUPERIOR BASIN |
| Betsy River | Stage- Discharge relationship developed by Michigan |
| Black River | USGS gauge 0310, DAR is 1.28 |
| Carp River | USGS gauge 0444, DAR is 1.44 |
| Chocolay River | Stage- Discharge relationship developed by Michigan |
| Dead River | Stage- Discharge relationship developed by Michigan |
| Falls River | Stage- Discharge relationship developed by Michigan |
| Iron River | Stage- Discharge relationship developed by Michigan |
| Mineral River | Stage- Discharge relationship developed by Michigan |
| Montreal River | Stage- Discharge relationship developed by Michigan |
| Ontonagon River | USGS gauge 0400, DAR is 1.04 |
| Presque Isle River | USGS gauge 0320, DAR is 1.37 |
| Silver River | Stage- Discharge relationship developed by Michigan |
| Sturgeon River | USGS gauge 0430, DAR is 1.03 |
| Tahquamenon River | USGS gauge 0455, DAR is 1.07 |
| Two Hearted River | Stage- Discharge relationship developed by Michigan |
| Waiska River | Stage- Discharge relationship developed by Michigan |
| | LAKE HURON BASIN |
| Au Gres River | USGS gauge 1385, DAR is 1.63 |
| Au Sable River | Stage- Discharge relationship developed by Michigan |
| Cheboygan River | USGS gauge 1300 and 1320, DAR is 1.04 for each one |
| Kawkawlin River | USGS gauge 1435, DAR is 2.22 |
| Ocqueoc River | Stage- Discharge relationship developed by Michigan |
| Pigeon River | Flow measurement coordinated with sampling |
| Pinconning River | Flow measurement coordinated with sampling |
| Pine River (Mackinac Co.) | USGS gauge 1279.18, DAR is 1.32 |
| Pine River (Arenac Co.) | Flow measurement coordinated with sampling |
| Pinnebog River | Flow measurement coordinated with sampling |
| Rifle River | USGS gauge 1420, DAR is 1.22 |
| Saginaw River | USGS gauge 1560, 1450, 1490, 1515, DAR is 1.24 for each one |
| Sebewaing River | Flow measurement coordinated with sampling |
| Tawas River | Flow measurement coordinated with sampling |
| Thunder Bay River | USGS Gauge 1335 and 1340, DAR is 1.65 for each |
| Whitney Drain | Flow measurement coordinated with sampling |
| Willow River | Flow measurement coordinated with sampling |

NOTE: USGS - United States Geological Survey

DAR - Drainage area ratio: the ratio between the drainage area of a basin, corresponding to the USGS gauge, to the drainage area of the basin corresponding to the sampling site.

APPENDIX B

LAND SOURCE INPUTS TO UPPER GREAT LAKES FROM THE U.S.

IJC - UPPER LAKES REFERENCE GROUP - WORKING GROUP C

# F I N A L  P R O J E C T  R E P O R T

July 20, 1976

This report is the culmination of two years of water quality data collection by Pollution Control Agencies representing Michigan, Minnesota and Wisconsin. From July 1, 1973 through June 30, 1975, about 100 land source inputs to Lakes Superior and Huron were sampled. The parameter coverage reported herein was guided by the Preliminary Study Plan for Working Group C. The intent of this report is to summarize two years of raw data and report on the loadings of selected constituents from Land Source Inputs to Lakes Superior and Huron.

## Method of Preparing Land Source Inputs

As a result of this two year study, an enormous volume of water quality data had been gathered. This data represented water quality of every significant land source input to the Upper Great Lakes: Sewage treatment plants, industrial facilities and tributary streams. Inter-laboratory comparisons of analytical techniques were maintained throughout the Project by the three agencies. This effort gives reasonable assurance that loadings of like parameters can be summed to represent the entire land source input to Lakes Superior and Huron from the United States. However, some parameters were reported differently and are therefore not additive (for example, calcium).

Since a need for common reporting formats for each agency was stipulated in the Study Plan, Michigan was asked to develop a computer program capable of rendering all data into report ready copy. The Federal (EPA) STORET system was utilized. This system is commonly in use for water quality data storage by all agencies. STORET consists of data storage and retrieval facilities for raw data, and with the IBM computers at the Washington Data Center, full computational capabilities were realized.

There are two types of formats showing Land Source Inputs. Format A is a summary of the various parameter inputs for a particular lake basin and reporting agency. A number of parameters are shown on each sheet. It is discussed in more detail later.

Format B is a listing by parameter of the input sources for a particular lake basin and reporting agency. Only one parameter is shown on each sheet. The following points should be noted on Format B:

1.) The parameter name is at the top. Below is the chemical species which it is expressed as (for example, ammonia might be expressed as $NH_3$ or as N). Below that are two other important pieces of information about the parameter -- whether it is analyzed as dissolved or total, and the lower limit of detection. For the purpose

of this report parameters analyzed as "total" indicate the sample is "unfiltered" prior to analysis. Two numbers are often used for "lower limit detection" in Format B. This is normally due to differences in techniques between stream samples and wastewater discharge samples.

2.) The tributary (T), municipal (M), and industrial (I) sources which have been measured are listed and numbered consecutively. They are in the same sequence on each parameter sheet.

3.) The "Period of Record" is the starting and ending dates of the data used. Generally, the period of record represents the study period, July 1, 1973 through June 30, 1975. However, Michigan included some industrial data collected in late 1972 and early 1973.

4.) In the data columns all units are metric as noted. English conversion factors for flow and loadings are listed in the lower left-hand corner.

5.) Mean loadings are calculated as follows, where n = no. of samples:

$$\text{mean loading in kg/day} = \frac{1}{n} \sum_{i=1}^{n} (\text{conc. in mg/l})_i (\text{flow in m}^3/\text{sec})_i (86.4)$$

6.) If $\bar{L}$ = mean loading, and $L_i$ = the individual loading values, i.e. $(\text{conc. in mg/l})_i (\text{flow in m}^3/\text{sec})_i (86.4)$, then standard deviation is calculated as follows:

$$\text{standard deviation in kg/day} = \sqrt{\frac{\sum_{i=1}^{n} (L_i - \bar{L})^2}{n-1}}$$

Non-random seasonal variations are taken into account by the periodic nature of the sampling program (monthly, with 3 extra samples taken during spring high flow periods). The standard deviations were calculated assuming that the data were random. Therefore, the mean loadings are really more accurate than would be indicated by the high standard deviations. Deseasonalized data would result in smaller, more accurate standard deviations.

7.) When <u>all</u> concentrations for a particular parameter at an input source are less than the limit of detection, the mean concentration and mean loading are listed as "ND" (not detectable). In other cases, <u>some</u> of the concentrations are not detectable, but some have measurable values. In these cases a value equal to one-half of the limit of detection is used in place of each non-detectable result when calculating mean concentrations and loadings. When this situation occurs the mean concentration may be less than the limit of detection ("ND" is not used).

8.) In addition to "ND", the following abbreviations are used in place of actual data as appropriate:

NP = Assumed not present in significant amount to warrant sampling.
NA = Not applicable (Such as loadings for dissolved oxygen, pH, turbidity, etc.)
NIL = Where intake concentration is greater than effluent concentration at industrial facilities.
NS = Not sampled.

9.) For some industries the mean concentration of a particular parameter will be the difference between the intake and effluent concentrations. In these cases, the concentration value is followed by the letter "N" to denote "Net". All other concentrations are gross values.

10.) Total dissolved solids in mg/l is obtained by multiplying conductivity in micromhos/cm by 0.65.

11.) For some parameters, a wide choice of analytical methods is possible. To avoid duplication of parameter types and to reduce the volume of this report, certain parameters were treated the same for all agencies. Regardless of the individual analytical method used, the following parameters were grouped:

1. Oil and Grease - 5 analytical methods were used
2. Turbidity - 3 analytical methods were used
3. Iron, Total - 2 analytical methods were used
4. Chemical Oxygen Demand - 2 analytical methods were used
5. Chromium, Dissolved - Hexavalent and Trivalent forms were grouped with dissolved.

12.) The contribution from the unsampled tributaries of an agency's lake basin is the last item listed on Format B. Loadings are calculated as follows:

Mean Loadings in KG/DAY = mean conc. of unsampled tributaries x flow of unsampled tributaries x 86.4.

The mean concentration of the unsampled tributaries is obtained using the mean concentration of a set of sampled tributaries. Each agency selected the following tributaries as representative of water quality in the unsampled basin:

Michigan - Lake Superior Basin: Presque Isle, Ontonagon, Silver, Tahquamenon and Two Hearted Rivers

Michigan - Lake Huron Basin: Ocqueoc, Pigeon, Pine and Willow Rivers and Van Etten Creek

Minnesota - Lake Superior Basin: Gooseberry, Split Rock, Beaver, Baptism, Manitou and Cross Rivers

Wisconsin - Lake Superior Basin: Bad, Bois Brule, Montreal, Nemadji Rivers

The flow of the unsampled tributaries was determined for each agency as follows, where n = number of sampled tributaries:

$$\text{Proportional flow} = \sum_{i=1}^{n} \text{Tributary flows} \times \text{proportionality constant}$$

The constant is the ratio of the unsampled drainage area to the sampled drainage area: the constants for each agency are:

Michigan - Lake Superior Basin - 0.56

Lake Huron Basin - 0.14

Minnesota - Lake Superior Basin - 0.09

Wisconsin - Lake Superior Basin - 1.04

13.) Radioactivity counting error is analogous to the standard deviation of the concentration. It is generally stated as the error at which the analyst is 95% confident that the measurements are accurate.

14.) Mean concentrations for coliforms are arithmetic means and not geometric means.

Format A

Format A is prepared from the completed Format B. For each parameter the various input sources are totaled in municipal, industrial, and tributary groups. The tributary totals include the estimated inputs from the unsampled portions of the basin.

1.) The "Loadings as % of Total" column on Format A is not completed for parameters with missing source type entries from Format B.

2.) Total solids and suspended solids are a gravimetric determination, Dissolved solids are computed from conductivity. Therefore, total solids will not be the summation of suspended solids and dissolved solids.

3.) Total nitrogen, Formats A and B, is calculated by summing nitrate, nitrite, organic and ammonia nitrogens. Total Kjeldahl nitrogen is not reported in STORET but rather its components, organic nitrogen and ammonia, are stored. For this project report total Kjeldahl nitrogen is the summation of organic nitrogen and ammonia.

Loadings of the Five Material Balance Parameters

The five material balance parameters are summarized in Tables 1 and 2 by Lake Basin, using the data collected during the study period (from Format A). The summary includes the estimate of loadings from the unsampled portions of each agency's drainage basin.

TABLE 1

LAKE SUPERIOR BASIN LAND SOURCE INPUTS

LOADINGS OF THE 5 MATERIAL BALANCE PARAMETERS

(Units are Kilograms/Day)

| INPUT TYPE/AGENCY | Chloride | Total Nitrogen | Total Phosphorus | Total Dissolved Solids | Silica ($SiO_2$*) |
|---|---|---|---|---|---|
| Municipal | | | | | |
| Michigan | 530 | 138 | 61.6 | 3,570 | 125 |
| Minnesota | 231 | 138 | 38.4 | 1,730 | 73.3 |
| Wisconsin | 774 | 407 | 165 | 5,840 | 135 |
| Industrial | | | | | |
| Michigan | 3,400 | 177 | 16.8 | 26,400 | Not Sampled |
| Minnesota | 3,400 | 108 | | 100,000 | 24,300 |
| Wisconsin | 317 | 16.8 | 4.8 | 9,640 | 89 |
| Tributary | | | | | |
| Michigan | 101,000 | 11,100 | 565 | 1,220,000 | 99,200 |
| Minnesota | 127,000 | 19,800 | 1,360 | 1,000,000 | 130,000 |
| Wisconsin | 10,100 | 13,300 | 2,520 | 840,000 | 105,000 |
| Unsampled Trib. | | | | | |
| Michigan | 10,000 | 4,000 | 172 | 656,000 | 60,800 |
| Minnesota | 5,000 | 1,510 | 74 | 78,500 | 16,100 |
| Wisconsin | 21,900 | 10,900 | 1,350 | 1,800,000 | 123,000 |

* Dissolved Silica- Michigan & Wisconsin
Total Silica - Wisconsin

TABLE 2

LAKE HURON BASIN LAND SOURCE INPUTS

LOADINGS OF THE 5 MATERIAL BALANCE PARAMETERS

(Units are Kilograms/Day)

| AGENCY/INPUT TYPE | Chloride | Total Nitrogen | Total Phosphorus | Total Dissolved Solids | Dissolved Silica ($SiO_2$) |
|---|---|---|---|---|---|
| Michigan | | | | | |
| Municipal | 11,900 | 891 | 170 | 58,500 | 1,340 |
| Industrial | 29,200 | 1,280 | 184 | 189,000 | 2,310 |
| Tributary | 1,110,000 | 68,000 | 5,750 | 9,800,000 | 234,000 |
| Unsampled Trib. | 149,000 | 10,300 | 472 | 1,500,000 | 28,200 |

# A P P E N D I X

## UPPER GREAT LAKES LAND SOURCE INPUTS

## PROJECT REPORT

## AMERICAN SOURCES

I. LAKE SUPERIOR BASIN -- Summary Format A

Michigan
Minnesota
Wisconsin

II. LAKE HURON BASIN - Summary Format A

Michigan

III. LAKE SUPERIOR BASIN - Land Source Inputs

Michigan
Minnesota
Wisconsin

IV. LAKE HURON BASIN - Land Source Inputs

Michigan

REFERENCES

1 "Land Source Inputs to Upper Great Lakes from the U.S.", IJC-ULRG-Working Group C, Final Project Report, July 20, 1976 by T. A. Newell, Comprehensive Studies Section, Bureau of Environmental Protection, Michigan Department of Natural Resources.